OUTLINE FOR LAB SESSION 1 – EC4440 Summer Quarter 2004

This laboratory deals with the interpretation of eigenvalues and eigenvectors of the correlation matrices for three different signals. The "random vectors" used to form the correlation matrix are formed by taking consecutive samples of the signal. The correlation exhibited in the 2×2 correlation matrix is the correlation between successive samples of the signal. All of the data has essentially zero mean so that the correlation and covariance matrices are identical and "uncorrelated" is the same as "orthogonal."

Part 1

1. Start MATLAB and type `load lab1` at the prompt.

2. Check to be sure the variables `s00`, `s01` and `s03` are present by typing the `whos` command.

3. Plot the three signals by typing `plotsigs(s00,s01,s03)` and observe the different temporal characteristics of the signals.

4. Form a data matrix `X01` corresponding to the signal `s01`. A convenient way to do this is to type:

   ```
   X01=reshape([s01 0 0 s01], 513,2);
   ```

   The resulting data matrix has size 513×2. (Don't forget the semicolon or all of the data will appear on your screen.)

5. Form a correlation matrix by typing: `R01=(X01'*X01)/512`

6. Type `[L,E] = steig(R01)` and make a note of the eigenvectors and eigenvalues.

7. Now, let's find the eigenvectors and eigenvalues by using the SVD of the data matrix.

   Type the commands: `[U,S,V]=svd(X01);` and `S1=S(1:2,1:2);`
   (The last command extracts the upper left portion of the singular value matrix `S`.)

Compare `V` to `E` computed above and compare the quantity `S1*S1/512` to `L` computed above.

8. Plot the data and concentration ellipse using `plotdata(X01,R01,2)` (The last argument (2) indicates that the ellipse will represent 2 standard deviations of the data. You can also try 1 or 3 for this last argument.)

9. Repeat steps 4 through 8 for the other signals `s00` and `s03`. Use the variables `X00` and `R00` for the data matrix and correlation matrix of `s00` and use `X03` and `R03` for the data matrix and correlation matrix of `s03`. Notice that while `s01` is *positively* correlated, `s00` is essentially *uncorrelated* and `s03` is *negatively* correlated.

10. Now let's apply the eigenvector transformation to the data. First type `[L,E] = steig(R01)` to be sure you have the eigenvector matrix corresponding to the data `s01`.

11. Type `Y=X01*E;` (don't forget the semicolon) to produce a matrix `Y` of new uncorrelated data samples. Form a correlation matrix for `Y` by typing `Ry=(Y'*Y)/512` and notice that `Ry` is diagonal. Compare it to the eigenvalue matrix of step 6.

12. Plot the new (transformed) data and its concentration ellipse: `plotdata(Y,Ry,2)` and compare it to the result you found when you ploted the original data X01 and *its* concentration ellipse. It may be helpful to rescale the axes of the plot by typing `axis([-10 10 -10 10])`.

Part 2

13. A special function "`ld`" is available for computing the triangular decomposition. Find the triangular decomposition of the correlation matrix by typing `[L,D]=ld(R01)`. Then compute the inverse matrix `L1=inv(L)`. Notice that `L1` is also lower triangular with ones on the diagonal.

14. Now repeat steps 11 and 12 of part 1 using the matrix `L1'` (don't forget the "prime") in place of `E`. This time, compare `Ry` to the matrix `D` computed in step 13. When you plot the data, it should appear uncorrelated.